Evaluation of Unionid Mussels, Lock and Dam 14 Lower Proposed Mooring Cell Sites, Mississippi River, RM 492

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Paul J. Marangelo and Heidi L. Dunn

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Ecological Specialists, Inc.
114 Algana Ct.
St. Peters, MO 63376

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13. ABSTRACT *(Maximum 200 words)*

The Army Corps of Engineers has proposed two locations for constructing a barge mooring cell below Lock and Dam 14 between MRM 491.5 and 492.9 east of the navigation channel in Rock Island County, IL. The purpose of this study was to determine if unionid beds occurred within the proposed sites. Unionids were semi-quantitatively sampled along six 100m transects within each site. Divers searched 10m intervals along each transect for 2 to 5 minutes collecting all unionids encountered. Both sites hosted low-density, species-poor unionid populations. However, one *Lampsilis higginsi* was found. Both sites appeared to be on the edge of unionid beds, as most unionids at Site 2 were at the downstream end, and most unionids were found along the shoreward edge of Site 1. Either site would be suitable for a mooring cell.

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1.0 Introduction

The Army Corps of Engineers (USACE) has proposed two locations for constructing a barge mooring cell below Lock and Dam 14 between MRM 491.5 and 492.9 east of the navigation channel in Rock Island County, IL. Both locations are near known unionid beds. Ecological Specialists, Inc. was contracted by USACE to evaluate the unionid communities in these locations.

Installation of a mooring cell could potentially have direct or indirect effects on unionids. Unionids living directly in the cell placement area may be crushed or dislodged during cell construction. Construction activities (such as staging equipment near banks and in the water, barge spudding, etc.) could also disturb substrate and streambanks resulting in resuspention of sediment, which can interfere with unionid respiration and feeding.

Also, turbulence from tows waiting in one area could dislodge unionids, alter currents, and re-suspend sediment (Miller *et al.,* 1989). Additionally, increased suspended solids within the waiting area and subsequent silt deposition downstream of waiting tows could smother unionids, clog gills, alter food availability, and disrupt host fish activity (USACE, 1996).

2.0 Methods

2.1 Field

Field sampling was conducted on 26 and 27, April 2000. Unionids were sampled by a diver along 12-100m transects (six transects per site) established perpendicular to the flow at RM 491.9-492.5. Transects endpoints were located using pre-determined GPS coordinates. Actual transect beginning and endpoints were recorded with GPS (Figure 2-1).

Five minute timed searches were conducted at 10m intervals in each transect. A diver collected unionids within 1m of the transect by visually searching the substrate and by disturbing the substrate by hand. Unionids collected from each 10m interval were placed in individual bags, identified, measured lengthwise, and sexed (if possible). Fresh-dead, weathered dead, and sub-fossil shells were recorded, but the latter two were only noted once per species, and subsequent weathered and sub-fossil shells were not enumerated. Also, the percentage of each shell surface infested with zebra mussels (*Dreissena polymorpha*) was visually estimated.

Substrate composition was visually classified into predominant and subdominant particle size categories using the Wentworth scale. Also, depth was measured at each 10m segment, and turbidity (Secchi depth), velocity (surface and bottom), and dissolved oxygen (DO) (surface and bottom) was measured once per site per sampling day. The number of unionids collected per transect segment was divided by the search time to obtain a measure of Catch Per Unit Effort (CPUE), which is expressed as the number of unionids collected in 10min of search effort per person.

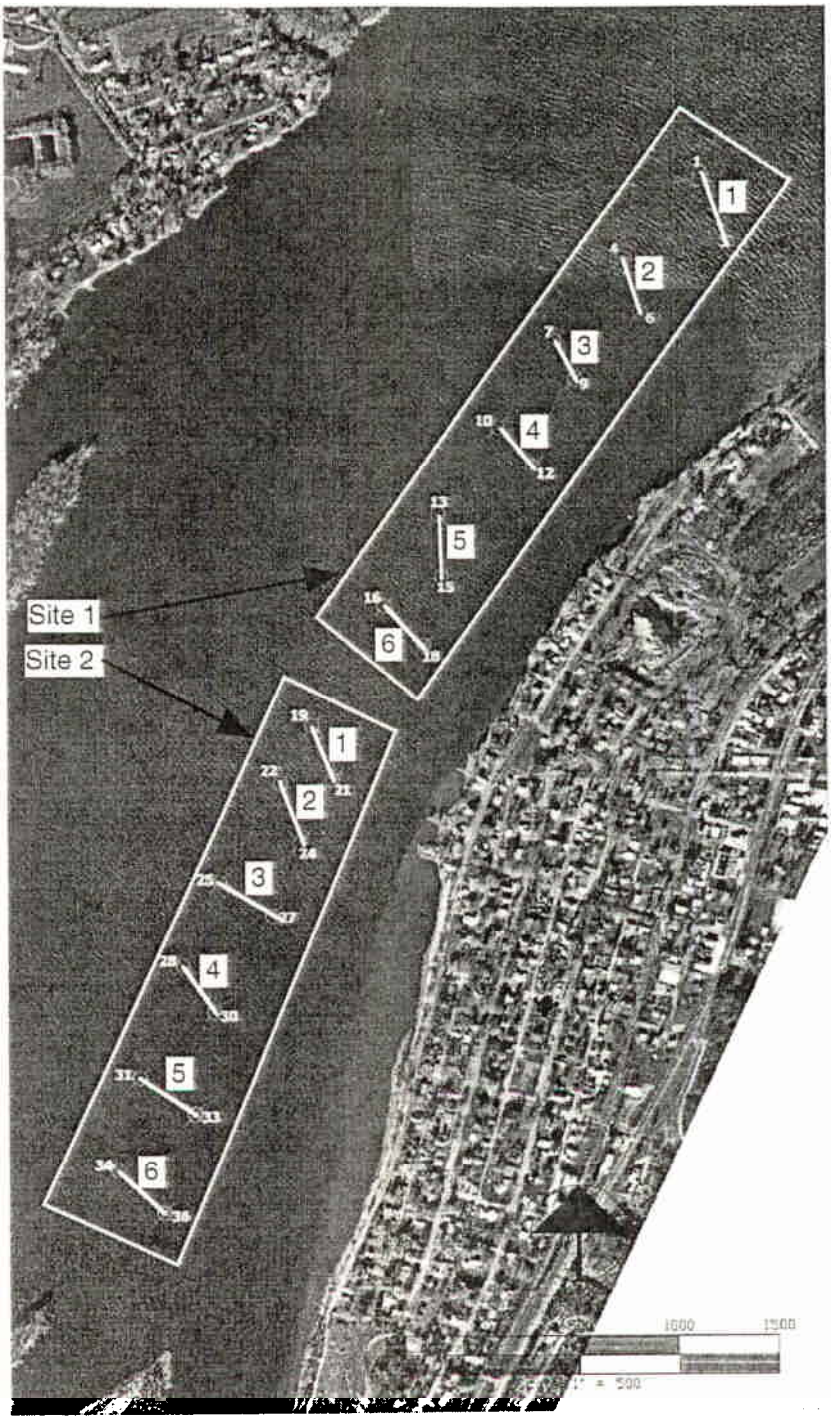
2.2 Data Analysis

In order evaluate diversity, Simpson's diversity index (D_s) was calculated. D_s is widely known and is mostly sensitive to the relative abundance of each species. It is computed with the formula:

$$l = (\Sigma n_i(n_i—1))/N(N-1)$$

where n_i is the number of unionids in the ith species, N is the total number of individuals, and l is a measure of species dominance. D_s is calculated by subtracting l from 1.

Species evenness was evaluated by comparing the least-squares slope of plots of the natural log of the relative abundance of each species vs. species abundance rank for each transect. A slope of zero represents a completely equitable distribution of species abundance, and larger slopes are indicative of communities dominated by a small number of (or single) species. Additionally, a size frequency histogram was plotted to evaluate the demographic structure of the unionid community in the study area.



Numbers near transect midpoints denote transect numbers.

ECOLOGICAL SPECIALISTS, INC.	Figure 2-1. Precise location of transects. Pool 15, April 2000.	ESI

3.0 Results and Discussion

3.1 Habitat

Current velocity in Site 1 was 60cm/sec and 55cm/sec at the bottom and surface of the river, respectively. Dissolved oxygen was 11.0mg/l (surface) and 11.8mg/l (bottom), water temperature was 13°C, and visibility was 350mm (Secchi). Substrate in Site 1 ranged from predominantly sand in Transects 1-3 with some bedrock and boulder, to a mixture of sand, cobble, and boulder in Transects 4-6. Some of the segments in Transects 1-3 hosted piles of unconsolidated sand. Depth was fairly uniform, ranging from 4.9-6.4m.

In Site 2, flow was 45cm/sec (bottom) and 48cm/sec (surface). Dissolved oxygen was 11.8 mg/l (bottom) and 11.0mg/l (surface), and transparency was 350mm (Secchi). Substrate was variable. Transects 1 and 2 consisted mostly of hard-packed sand and boulder, with some cobble and silt. Transect 3 was mostly sand and clay, Transect 4 was a mixture of sand, cobble, and boulder, and Transects 5 and 6 were mostly sand with some gravel and silt. Depth varied more than Site 1; Transects 1-3 ranged from 4.3-4.9m, and Transects 4-6 ranged from 2.4-4.0m.

3.2 Unionid community

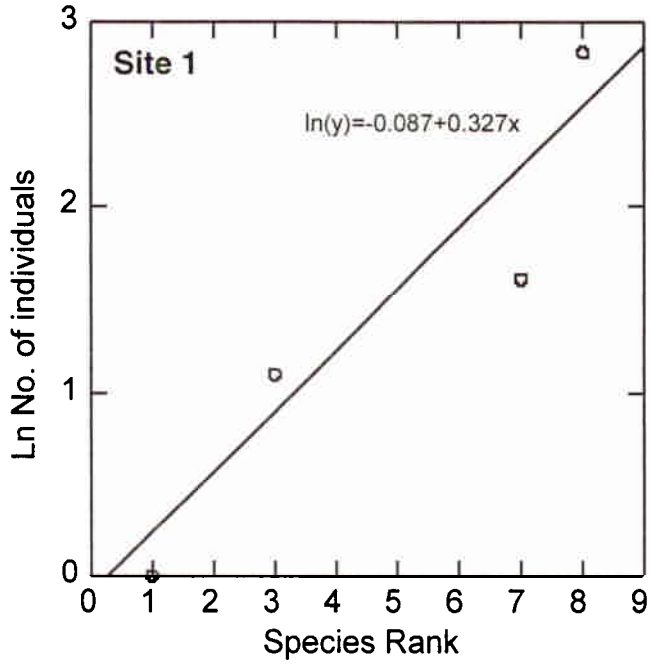
Both sites in the study area hosted low-density, species-poor unionid populations. At Site 1, 35 unionids of seven species were collected (Table 3-1), including one individual of the federally endangered *Lampsilis higginsi*, while Site 2 yielded 22 unionids of seven species (see Table 3-1). Overall, a total of nine species of live unionids were found in the study area. *Quadrula p. pustulosa* (49%) and *Amblema p. plicata* (21%), were the most abundant species in the study area, while *Obliquaria reflexa* (9%), *Obovaria olivaria* (5%), *Ligumia recta* (5%), and *Lampsilis cardium* were moderately abundant. *Lampsilis higginsi*, *Quadrula quadrula*, and *Leptodea fragilis* were rare (<2%). Unionid density was similar between the two sites: Site 1 averaged 0.58 unionids/transect segment ($10m^2$) (CPUE =1.2/10 min), while Site 2 averaged 0.36 unionids/transect segment (CPUE=0.7/10min). Simpson's D_s for Sites 1 and 2 were 0.28 and 0.24, respectively (see Table 3-1), while species evenness slopes were 0.33 and 0.49, respectively (Figure 3-1). It should be noted that Simpson's D_s tends to display high variance for low density populations (ESI, 2000) such as found in Sites 1 and 2, thus diminishing the usefulness of this index for comparisons to other areas.

A small percentage of the population (7%) were juveniles (<40mm), though too few unionids were collected to derive strong conclusions about reproductive activity in the study area (Figure 3-2). Moreover, all four individuals classified as juveniles by our length criteria were of common species whose adults are relatively small in terms of length (*O. reflexa* and *Q. p. pustulosa*). It is likely that some juveniles were not collected by our sampling methods, as visual and tactile searches are typically biased against smaller size class unionids (Miller and Payne, 1988; Vaughn *et al.*, 1997; Hornbach and Deneka,

Table 3-1. Number and species of unionids collected in Pool 15, April 2000.

Species	Site 1	Site 2	Total	Relative abundance (%)
Actinonaias ligamentina		WD	WD	
Amblema p. plicata	5	7	12	21.1
Arcidens confragosus		WD	WD	
Cyclonaias tuberculata		SF	SF	
Ellipsaria lineolata	FD	FD	FD	
Fusconaia ebena		SF	SF	
Lampsilis cardium	3	FD	3	5.3
Lampsilis higginsi	1		1	1.8
Leptodea fragilis	FD	1	1	1.8
Ligumia recta	3	WD	3	5.3
Megalonaias nervosa		FD	FD	
Obliquaria reflexa	3	2	5	8.8
Obovaria olivaria	3		3	5.3
Potamilus alatus		WD	WD	
Potamilus ohiensis		WD	WD	
Pyganodon grandis	FD	WD	FD	
Quadrula metanevra		SF	SF	
Quadrula nodulata		WD	WD	
Quadrula p. pustulosa	17	11	28	49.1
Quadrula quadrula	FD	1	1	1.8
Truncilla truncata		WD	WD	
Total	35	22	57	
CPUE	1.2	0.7	0.9	
No./10m^2 segment	0.58	0.36	0.47	
Species Richness	7	5	9	
Simpson's D_s	0.28	0.24	0.29	

FD=fresh dead, WD=weathered dead, SF=sub-fossil



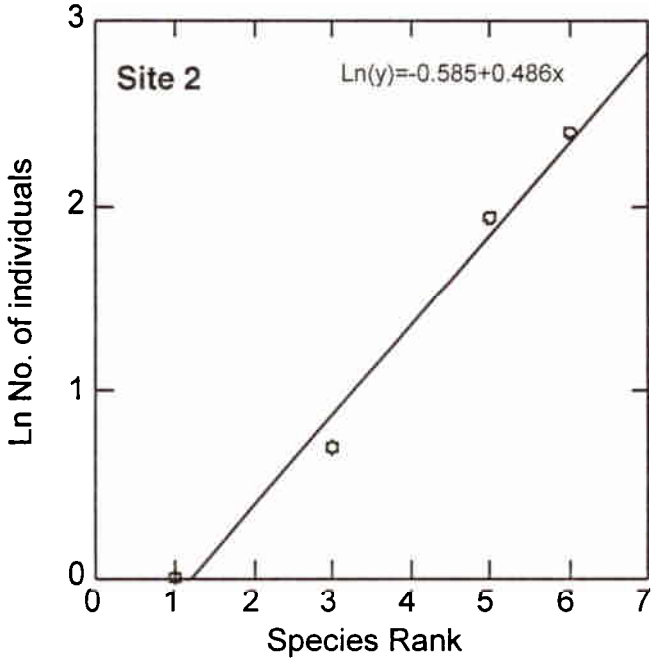


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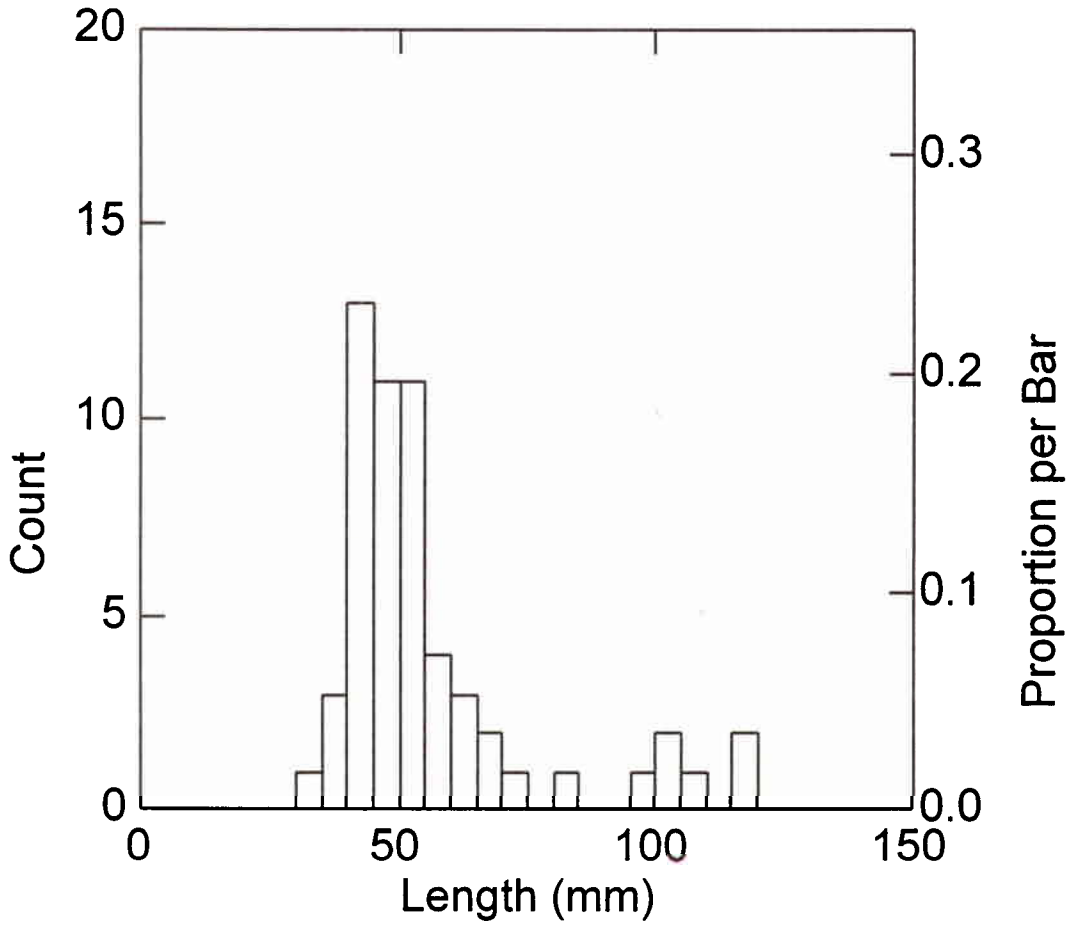
Figure 3-1. Species evenness curves for Sites 1 and 2, Pool 15, April 2000.

ESI



ECOLOGICAL SPECIALISTS, INC.	Figure 3-2. Length frequency histogram of unionids collected in Pool 15, April 2000.	ESI

1996). Nevertheless, the overall scarcity of unionids probably renders such bias unimportant, as the number of overlooked individuals would likely not be sufficient to upgrade the evaluation of the unionid population in the study area.

3.3 Distribution

Unionids were sparsely distributed throughout Sites 1 and 2 (Table 3-2). In Site 2, the downstream most transect (Transect 6) might be on the edge of a unionid bed, as unionids were more abundant here than in the five transects immediately upstream (see Table 3-2). Site 1 also appears to be located on the edge of a unionid bed, as 23 of the 35 unionids collected at this site were found on transects between 0 and 10m on the eastern boundary of Site 1. This is consistent with the *L. higginsi* collection location (see Table 3-2), as *L. higginsi* is typically found in unionid beds with a much higher diversity and abundance than we found Site 1 (Hornbach, 1998; Wilcox *et al.*, 1993).

Unionid distribution did not appear to be related to substrate in either of Sites 1 or 2. Indeed, the prevalence of large particle sizes and hard-packed sand in some areas of the study area appear that it could support more unionids than were collected. Unionids are typically found in areas with clean, stable substrate consisting of cobble, gravel, and sand, whereas they are rarely found in unstable substrate (Cvancara, 1970; Strayer and Ralley, 1991) because they are unable to maintain their natural position, and may be buried or displaced during fluvial events. Unionids are typically found in areas with sufficient flow to prevent sedimentation, but without enough flow to render the substrate unstable (Vaughn, 1997). This general description of habitat criteria for unionids appears to fit much of the study area, except Transects 5 and 6 in Site 2, which were mostly sand.

3.4 Zebra mussel infestation

Unionids were moderately fouled in the study area. Eighty six (86)% of the unionids collected were infested with at least one zebra mussel, and the percentage of shell surface of zebra mussels covered by zebra mussels averaged 28.3%. While it is not clear whether this level of infestation poses an acute threat to unionids in the study area, future increases in infestation will probably lead to unionid mortality.

Table 3-2. Distribution of unionids in Sites 1 and 2, Pool 15, April 2000.

Site 1	Dist. on transect[1]	Transect 1	2	3	4	5	6	Total
	0m		9	4	2	2	6	23
	10m				1		6	7
	20m							0
	30m							0
	40m							0
	50m							0
	60m							0
	70m							0
	80m			5				5
	90m							0
Total		0	9	9	3	2	12	35

Site 2		Transect 1	2	3	4	5	6	Total
	0m	2		2		1		5
	10m				2		2	4
	20m						2	2
	30m	1				2	2	5
	40m							0
	50m							0
	60m						3	3
	70m		1					1
	80m							0
	90m		2					2
Total		3	3	2	2	3	9	22

shaded table cell denotes *L. higginsi* collection location
[1]distance on transect from east boundary of study area.

4.0 Conclusions

Compared to other areas of the Mississippi River, the study area hosts a sparse, species-poor unionid community. However, one *L. higginsi* specimen was collected near the eastern edge of Site 1, and a relatively larger concentration of unionids in this area (see Table 3-2) suggests that there is a more productive and diverse unionid bed adjacent to the eastern edge of Site 1. Otherwise, there was little difference between Sites 1 and 2 in terms of unionid abundance and diversity.

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Appendix A. Database from Sites 1 and 2, Mississippi River, Pool 15, April 2000.

Study ID	ESI project	month	day	year	State	Bank	min dist bank (m)	max dist bank (m)	Coll method	sample area (m)	time (min)	Depth (ft)	Species	Site	Transect	#Live	#FD	#WD	#SF	Age (years)	Length (mm)	Weight (g)	reproductive condition	comments	zebras per unionid
2k-008	2k-008	4	26	2000	Iowa	left	90	100	semi-quan	10		16	Leptodea fragilis	2	T1	0	0	0	1					cobble with sand	
							90	100					Fusconaia ebena	2	T1	0	0	0	1						
2k-008	2k-008	4	26	2000	Iowa	left	80	90	semi-quan	10		16	Quadrula p. pustulosa	2	T1	0	0	0	1					cobble with silt	
							80	90					Leptodea fragilis	2	T1	0	0	0	1						
							80	90					Lampsilis cardium	2	T1	0	0	0	1						
							80	90					Truncilla truncata	2	T1	0	0	0	1						
2k-008	2k-008	4	26	2000	Iowa	left	70	80	semi-quan	10		16	Quadrula quadrula	2	T1	0	0	0	1					cobble with sand	
							70	80					Potamilus alatus	2	T1	0	0	0	1						
							70	80					Quadrula p. pustulosa	2	T1	0	0	1	0						
2k-008	2k-008	4	26	2000	Iowa	left	60	70	semi-quan	10		16	none	2	T1									cobble with sand	
2k-008	2k-008	4	26	2000	Iowa	left	50	60	semi-quan	10		16	Quadrula p. pustulosa	2	T1	0	1	0	0					cobble with sand turning into more boulder; hard packed	
2k-008	2k-008	4	26	2000	Iowa	left	40	50	semi-quan	10		16	Ellipsaria lineolata	2	T1	0	0	0	1					cobble with sand turning into more boulder; hard packed	
							40	50					Quadrula metanevra	2	T1	0	0	0	1						
2k-008	2k-008	4	26	2000	Iowa	left	30	40	semi-quan	10		16	Quadrula p. pustulosa	2	T1	1	0	0	0		43			hard packed sand and boulder	80
							30	40					Truncilla truncata	2	T1	0	0	1	0						
							30	40					Megalonaias nervosa	2	T1	0	1	0	0						
							30	40					Obliquaria reflexa	2	T1	0	0	1	0						
							30	40					Fusconaia ebena	2	T1	0	0	0	1						
2k-008	2k-008	4	26	2000	Iowa	left	20	30	semi-quan	10		16	Arcidens confragosus	2	T1	0	0	1	0					hard packed sand and boulder	
							20	30					Pyganodon grandis	2	T1	0	0	1	0						
							20	30					Amblema p. plicata	2	T1	0	0	1	0						
							20	30					Quadrula quadrula	2	T1	0	0	0	1						
							20	30					Cyclonaias tuberculata	2	T1	0	0	0	1						
2k-008	2k-008	4	26	2000	Iowa	left	10	20	semi-quan	10		16	Obliquaria reflexa	2	T1	0	1	0	0					hard packed sand and boulder	
							10	20					Potamilus alatus	2	T1	0	0	1	0						
							10	20					Quadrula nodulata	2	T1	0	0	1	0						
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10		16	Amblema p. plicata	2	T1	1	0	0	0		69			hard packed sand and boulder	2
							0	10					Amblema p. plicata	2	T1	1	0	0	0		82				5
2k-008	2k-008	4	26	2000	Iowa	left	90	100	semi-quan	10		16	Obliquaria reflexa	2	T2	1	0	0	0		38			hard packed sand and boulder	20
							90	100					Quadrula p. pustulosa	2	T2	1	0	0	0		35				0
							90	100					Ligumia recta	2	T2	0	0	1	0						
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2k-008	2k-008	4	26	2000	Iowa	left	70	80	semi-quan	10		15	Amblema p. plicata	2	T2	1	0	0	0		51			hard packed sand and boulder	30
							70	80					Lampsilis cardium	2	T2	0	0	1	0						
							70	80					Leptodea fragilis	2	T2	0	0	1	0						
2k-008	2k-008	4	26	2000	Iowa	left	60	70	semi-quan	10		15	none	2	T2									hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	50	60	semi-quan	10		16	none	2	T2									hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	40	50	semi-quan	10		16	none	2	T2									hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	30	40	semi-quan	10		15	none	2	T2									hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	20	30	semi-quan	10		15	none	2	T2									hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	10	20	semi-quan	10		15	none	2	T2									hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10		15	Amblema p. plicata	2	T2	0	1	0	0					hard packed sand and boulder	
2k-008	2k-008	4	26	2000	Iowa	left	90	100	semi-quan	10	2	15	none	2	T3									sand and cobble	
2k-008	2k-008	4	26	2000	Iowa	left	80	90	semi-quan	10	2	15	none	2	T3									sand and clay	
2k-008	2k-008	4	26	2000	Iowa	left	70	80	semi-quan	10	2	16	none	2	T3									sand and clay	
2k-008	2k-008	4	26	2000	Iowa	left	60	70	semi-quan	10	2	15	none	2	T3									sand and clay	
2k-008	2k-008	4	26	2000	Iowa	left	50	60	semi-quan	10	2	15	none	2	T3									sand and clay	

Study ID	ESI project	month	day	year	State	Bank	min dist bank (m)	max dist bank (m)	Coll method	sample area (m)	time (min)	Depth (ft)	Species	Site	Transect	#Live	#FD	#WD	#SF	Age (years)	Length (mm)	Weight (g)	reproductive condition	comments	zebras per unionid
2k-008	2k-008	4	26	2000	Iowa	left	40	50	semi-quan	10	2	15	none	2	T3									sand and clay	
2k-008	2k-008	4	26	2000	Iowa	left	30	40	semi-quan	10	2	15	none	2	T3									sand/cobble/boulder	
2k-008	2k-008	4	26	2000	Iowa	left	20	30	semi-quan	10	2	14	none	2	T3									sand	
2k-008	2k-008	4	26	2000	Iowa	left	10	20	semi-quan	10	2	14	none	2	T3									sand and cobble	
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10	2	14	Quadrula p. pustulosa	2	T3	1	0	0	0		43			sand/cobble/boulder	95
							0	10	semi-quan				Quadrula p. pustulosa	2	T3	1	0	0	0		43				50
							0	10	semi-quan				Actinonaias ligamentina	2	T3	0	0	1	0						
2k-008	2k-008	4	26	2000	Iowa	left	90	100	semi-quan	10	2	13	none	2	T4									boulder/sand	
2k-008	2k-008	4	26	2000	Iowa	left	80	90	semi-quan	10	2	13	none	2	T4									boulder/sand	
2k-008	2k-008	4	26	2000	Iowa	left	70	80	semi-quan	10	2	13	none	2	T4									cobble/sand	
2k-008	2k-008	4	26	2000	Iowa	left	60	70	semi-quan	10	2	13	none	2	T4									cobble/sand	
2k-008	2k-008	4	26	2000	Iowa	left	50	60	semi-quan	10	2	13	none	2	T4									boulder/sand	
2k-008	2k-008	4	26	2000	Iowa	left	40	50	semi-quan	10	2	13	none	2	T4									cobble/sand to sand	
2k-008	2k-008	4	26	2000	Iowa	left	30	40	semi-quan	10	2	13	none	2	T4									sand	
2k-008	2k-008	4	26	2000	Iowa	left	20	30	semi-quan	10	2	13	none	2	T4									sand	
2k-008	2k-008	4	26	2000	Iowa	left	10	20	semi-quan	10	2	13	Quadrula p. pustulosa	2	T4	1	0	0	0		43			sand	50
						left	10	20	semi-quan				Quadrula p. pustulosa	2	T4	1	0	0	0		48				50
						left	10	20	semi-quan				Ellipsaria lineolata	2	T4	0	1	0	0						
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10	2	13	none	2	T4									sand	
2k-008	2k-008	4	26	2000	Iowa	left	90	100	semi-quan	10	2	11	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	80	90	semi-quan	10	2	11	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	70	80	semi-quan	10	2	11	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	60	70	semi-quan	10	2	11	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	50	60	semi-quan	10	2	11	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	40	50	semi-quan	10	2	10	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	30	40	semi-quan	10	2	11	Amblema p. plicata	2	T5	1	0	0	0		54			sand	50
							30	40					Quadrula p. pustulosa	2	T5	1	0	0	0		48				50
							30	40					Lampsilis cardium	2	T5	0	1	0	0						
2k-008	2k-008	4	26	2000	Iowa	left	20	30	semi-quan	10	2	11	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	10	20	semi-quan	10	2	10	none	2	T5									sand	
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10	2	11	Quadrula quadrula	2	T5	1	0	0	0		51			sand	50
2k-008	2k-008	4	26	2000	Iowa	left	90	100	semi-quan	10	2	9	none	2	T6									sand/gravel	
2k-008	2k-008	4	26	2000	Iowa	left	80	90	semi-quan	10	2	9	none	2	T6									sand	
2k-008	2k-008	4	26	2000	Iowa	left	70	80	semi-quan	10	2	9	none	2	T6									sand	
2k-008	2k-008	4	26	2000	Iowa	left	60	70	semi-quan	10	2	7	Quadrula nodulata	2	T6	0	0	1	0					sand	
							60	70	semi-quan	10	2	7	Quadrula p. pustulosa	2	T6	0	1	0	0						
							60	70	semi-quan	10	2	7	Truncilla truncata	2	T6	0	0	1	0						
							60	70	semi-quan	10	2	7	Leptodea fragilis	2	T6	1	0	0	0		62				10
							60	70	semi-quan	10	2	7	Amblema p. plicata	2	T6	1	0	0	0		54				20
							60	70	semi-quan	10	2	7	Amblema p. plicata	2	T6	1	0	0	0		53				80
2k-008	2k-008	4	26	2000	Iowa	left	50	60	semi-quan	10	2	8	none	2	T6									sand with 1" of silt	
2k-008	2k-008	4	26	2000	Iowa	left	40	50	semi-quan	10	2	8	none	2	T6									sand with 1" of silt	
2k-008	2k-008	4	26	2000	Iowa	left	30	40	semi-quan	10	2	9	Obliquaria reflexa	2	T6	1	0	0	0		36			sand	75
							30	40	semi-quan	10	2	9	Quadrula p. pustulosa	2	T6	1	0	0	0		44				10
2k-008	2k-008	4	26	2000	Iowa	left	20	30	semi-quan	10	2	8	Potamilus ohiensis	2	T6	0	0	1	0					sand	
							20	30	semi-quan	10	2	8	Amblema p. plicata	2	T6	1	0	0	0		64				20
							20	30	semi-quan	10	2	8	Quadrula p. pustulosa	2	T6	1	0	0	0		44				50
2k-008	2k-008	4	26	2000	Iowa	left	10	20	semi-quan	10	2	8	Quadrula p. pustulosa	2	T6	1	0	0	0		48			sand	40
							10	20	semi-quan	10	2	8	Quadrula p. pustulosa	2	T6	1	0	0	0		52				50
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10	2	9	none	2	T6									sand	
2k-008	2k-008	4	26	2000	Iowa	left	10	100	semi-quan	90	18	17	Amblema p. plicata	1	T6	0	1	0	0					sand/cobble	
							10	100	semi-quan	90	18	17	Obliquaria reflexa	1	T6	1	0	0	0		43				50
							10	100	semi-quan	90	18	17	Quadrula p. pustulosa	1	T6	1	0	0	0		48				20
							10	100	semi-quan	90	18	17	Quadrula p. pustulosa	1	T6	1	0	0	0		55				25
							10	100	semi-quan	90	18	17	Quadrula p. pustulosa	1	T6	1	0	0	0		44				75
							10	100	semi-quan	90	18	17	Lampsilis cardium	1	T6	1	0	0	0		100		female		0
							10	100	semi-quan	90	18	17	Lampsilis cardium	1	T6	1	0	0	0		102		male		5
2k-008	2k-008	4	26	2000	Iowa	left	0	10	semi-quan	10	2	16	Ellipsaria lineolata	1	T6	0	1	0	0					sand/cobble and some boulders	
							0	10	semi-quan	10	2	16	lampsilis higginsi	1	T6	1	0	0	0		72		female, not gravid		50
							0	10	semi-quan	10	2	16	Quadrula p. pustulosa	1	T6	1	0	0	0						10

Study ID	ESI project	month	day	year	State	Bank	min dist bank (m)	max dist bank (m)	Coll method	sample area (m)	time (min)	Depth (ft)	Species	Site	Transect	#Live	#FD	#WD	#SF	Age (years)	Length (mm)	Weight (g)	reproductive condition	comments	zebras per unionid	
							0	10	semi-quan	10	2	16	Amblema p. plicata	1	T6	1	0	0	0		56				70	
							0	10	semi-quan	10	2	16	Amblema p. plicata	1	T6	1	0	0	0		64				50	
							0	10	semi-quan	10	2	16	Ligumia recta	1	T6	1	0	0	0		118		female		60	
							0	10	semi-quan	10	2	16	Ligumia recta	1	T6	1	0	0	0		115		male		50	
2k-008	2k-008	4	26	2000	Iowa	left	0	100	semi-quan	100	20	19	Ligumia recta	1	T5	1	0	0	0		106		female	lots of byssals	5	
						left	0	100	semi-quan	100	20	19	Quadrula p. pustulosa	1	T5	1	0	0	0		43				2	
						left	0	100	semi-quan	100	20	19	Pyganodon grandis	1	T5	0	1	0	0							
						left	0	100	semi-quan	100	20	19	Ligumia recta	1	T5	0	1	0	0							
2k-008	2k-008	4	27	2000	Iowa	left	90	100	semi-quan	10	2	21	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	80	90	semi-quan	10	2	21	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	70	80	semi-quan	10	2	21	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	60	70	semi-quan	10	2	20	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	50	60	semi-quan	10	2	20	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	40	50	semi-quan	10	2	19	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	30	40	semi-quan	10	2	19	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	20	30	semi-quan	10	2	19	none	1	T4									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	10	20	semi-quan	10	2	19	Obovaria olivaria	1	T4	1	0	0	0		47			sand/boulder	0	
2k-008	2k-008	4	27	2000	Iowa	left	0	10	semi-quan	10	5	20	Quadrula p. pustulosa	1	T4	1	0	0	0		51			sand/boulder	60	
							0	10					Quadrula p. pustulosa	1	T4	1	0	0	0		43				40	
2k-008	2k-008	4	27	2000	Iowa	left	90	100	semi-quan	10	2	21	none	1	T3									sand/boulder/debris		
2k-008	2k-008	4	27	2000	Iowa	left	80	90	semi-quan	10	5	21	Lampsilis cardium	1	T3	1	0	0	0		98		female	sand/cobble	10	
						left	80	90	semi-quan				Obliquaria reflexa	1	T3	1	0	0	0		40				40	
						left	80	90	semi-quan				Amblema p. plicata	1	T3	1	0	0	0		59				0	
						left	80	90	semi-quan				Quadrula p. pustulosa	1	T3	1	0	0	0		42				0	
						left	80	90	semi-quan				Quadrula p. pustulosa	1	T3	1	0	0	0		52				40	
2k-008	2k-008	4	27	2000	Iowa	left	70	80	semi-quan	10	2	21	none	1	T3									sand		
2k-008	2k-008	4	27	2000	Iowa	left	60	70	semi-quan	10	2	21	none	1	T3									sand/boulder		
2k-008	2k-008	4	27	2000	Iowa	left	50	60	semi-quan	10	2	21	none	1	T3									sand/boulder/debris		
2k-008	2k-008	4	27	2000	Iowa	left	40	50	semi-quan	10	2	21	none	1	T3									sand dune		
2k-008	2k-008	4	27	2000	Iowa	left	30	40	semi-quan	10	2	21	none	1	T3									sand dune		
2k-008	2k-008	4	27	2000	Iowa	left	20	30	semi-quan	10	2	21	none	1	T3									sand dune		
2k-008	2k-008	4	27	2000	Iowa	left	10	20	semi-quan	10	2	19	none	1	T3									sand dune		
2k-008	2k-008	4	27	2000	Iowa	left	0	10	semi-quan	10	2	19	Obovaria olivaria	1	T3	1	0	0	0		54			sand dune	10	
						left	0	10	semi-quan				Quadrula p. pustulosa	1	T3	1	0	0	0		46				0	
						left	0	10	semi-quan				Quadrula p. pustulosa	1	T3	1	0	0	0		46				20	
						left	0	10	semi-quan				Quadrula p. pustulosa	1	T3	1	0	0	0		46				10	
2k-008	2k-008	4	27	2000	Iowa	left	80	100	semi-quan	20	4	18	Obliquaria reflexa	1	T2	1	0	0	0		42				5	
						left	80	100	semi-quan	20	4	18	Obovaria olivaria	1	T2	1	0	0	0		53				0	
						left	80	100	semi-quan	20	4	18	Amblema p. plicata	1	T2	1	0	0	0		68				2	
						left	80	100	semi-quan	20	4	18	Quadrula p. pustulosa	1	T2	1	0	0	0		48				5	
						left	80	100	semi-quan	20	4	18	Quadrula p. pustulosa	1	T2	1	0	0	0		49				2	
						left	80	100	semi-quan	20	4	18	Quadrula p. pustulosa	1	T2	1	0	0	0		54				5	
						left	60	70	semi-quan	10	2	19	Lampsilis cardium	1	T2	0	1	0	0							
						left	60	70	semi-quan	10	2	19	Quadrula p. pustulosa	1	T2	0	1	0	0							
						left	60	70	semi-quan	10	2	19	Quadrula p. pustulosa	1	T2	0	1	0	0							
						left	60	70	semi-quan	10	2	19	Ellipsaria lineolata	1	T2	0	1	0	0							
						left	60	70	semi-quan	10	2	19	Obovaria olivaria	1	T2	0	1	0	0							
						left	60	70	semi-quan	10	2	19	Amblema p. plicata	1	T2	0	1	0	0							
						left	60	70	semi-quan	10	2	19	Quadrula p. pustulosa	1	T2	1	0	0	0		30				0	
						left	60	70	semi-quan	10	2	19	Quadrula p. pustulosa	1	T2	1	0	0	0		46				2	
						left	60	70	semi-quan	10	2	19	Amblema p. plicata	1	T2	1	0	0	0		55				5	28.333333
2k-008	2k-008	4	27	2000	Iowa	left	70	80	semi-quan	10	2	19	none	1	T2									sand dune		
2k-008	2k-008	4	27	2000	Iowa	left	50	60	semi-quan	10	2	18	none	1	T2									sand dune/bedrock		
2k-008	2k-008	4	27	2000	Iowa	left	40	50	semi-quan	10	2	16	none	1	T2									sand		
2k-008	2k-008	4	27	2000	Iowa	left	30	40	semi-quan	10	2	16	none	1	T2									sand		
2k-008	2k-008	4	27	2000	Iowa	left	20	30	semi-quan	10	2	17	none	1	T2									sand		
2k-008	2k-008	4	27	2000	Iowa	left	10	20	semi-quan	10	2	19	none	1	T2									sand		
2k-008	2k-008	4	27	2000	Iowa	left	0	10	semi-quan	10	2	19	none	1	T2									sand		
2k-008	2k-008	4	27	2000	Iowa	left	0	100	semi-quan	100	20	19	Leptodea fragilis	1	T1	0	1	0	0							
						left	0	100	semi-quan	100	20	19	Amblema p. plicata	1	T1	0	1	0	0							
						left	0	100	semi-quan	100	20	19	Ellipsaria lineolata	1	T1	0	1	0	0							
						left	0	100	semi-quan	100	20	19	Quadrula quadrula	1	T1	0	1	0	0							

Appendix B. Scope of Work

SCOPE-OF-WORK

EVALUATION OF UNIONID MUSSELS, L/D 14 LOWER PROPOSED MOORING CELL SITES 1 & 2, UPPER POOL 15, MISSISSIPPI RIVER, ROCK ISLAND COUNTY, ILLINOIS

Prepared by Randy J. Kraciun, CEMVR-PM-R, X5174

14 March 2000

I. CONTRACT PROVISIONS IN FORCE

1.1 Provisions of the Scope-of-work (SOW) in the main contract shall apply to this Work Order as required to fulfill the requirements of the main contract and to accomplish the work set out in the Specifications, below, and are not repeated here.

II. PROJECT OBJECTIVE, LOCATION AND COORDINATION WITH OTHER FIELD WORK

2.1 The Rock Island District U.S. Army Corps of Engineers (Corps) is examining the potential for placement of a new mooring cell below L/D (Lock and Dam) 14 on the Upper Mississippi River. Two potential sites for the mooring cell have been identified between river miles (RM) 491.5-493.0 (Fig. 1). A known mussel bed, used commercially in the past, is located on the left descending bank, at RM 492.4L adjacent to Illiniwek State Park in Illinois. The purpose of this effort is to determine the extent of impacts to mussels at either site, if selected. Primary tasks to be performed include: (1) perform a series of diver transects at each site to evaluate unionid species abundance and composition and (2) prepare a short technical report describing results of the survey.

2.2 **Field work for this Delivery Order is to be accomplished in conjunction with the field work for survey of unionid mussels at Bellevue, Iowa, County Highway 52, Section 14 Streambank Stabilization, Pool 13, Mississippi River, Jackson County, Iowa.**

III. REGULATORY REQUIREMENTS AND AUTHORITIES

3.1 The Contractor will be responsible for securing all applicable sampling permits from the State and Federal Governments.

IV. BACKGROUND

4.1 The project proposes plans and specifications for the installation of a new mooring cell below Lock & Dam 14 on the Mississippi River. Currently during upbound lockage exchanges, tows must wait several miles downstream until the downbound tow exits the lock. The construction of a mooring cell just downstream of the lock would enable upbound tows to wait closer to the lock, increasing transit efficiency. Unfortunately, there is a known mussel bed within the vicinity on the proposed mooring cell sites. The mussel bed is located along the left descending bankline, adjacent to Illiniwek State Park in Illinois. The problem then is to try to locate mooring facilities that are close to the lock, yet have a minimum impact to area mussels.

4.2 Review of depth surveys, conducted by CEMVR in 1996 reveals two potential locations for mooring facilities to be located in upper Pool 15.

1). Site 1 is located at approximately RM 492.5L.

2). Site 2 is located at approximately RM 491.9L

4.3 Both sites are located close enough to a known mussel bed to raise concerns for potential impacts to area mussels. The best situation would be to find an area with no mussels and construct the mooring cell there. A potential alternative would be to find an area of low mussel density for the project.

4.4 The navigation industry's current preferred location is Site 2, based on existing red buoy locations.

4.5 The Corps is proposing Site 1 as a more desirable location. However, this location is subject to the relocation of four red channel marker buoys.

V. SPECIFICATIONS.

5.1 Study sites: Two survey areas will be evaluated as potential sites for mooring cell placement. Proposed Site 1 is located on the left descending bank at RM 492.5 (NAD 27 Illinois West, State Plane: x=433640.3, y=1784465.7). The area for survey will be 100 m (meters) wide and extend downstream for a length of 1000 m. Proposed Site 2 is located on the left descending bank at RM 491.9 (NAD 27 Illinois West, State Plane: x=431818.9, y=178150.5). The area for survey will be 100 m (meters) wide and will extend downstream for a length of 1000 m. It is anticipated that the substrate for this area is rock cobble to bedrock.

5.2 Sampling technique: Divers will conduct semi-quantitative sampling using 5-min searches spaced at 10-m intervals along a 100-m transect line (divers transect). At each 10-m interval the diver will collect all mussels within 1 meter of the transect line. A series of diver transects will be conducted at 200-m intervals within each of the two sites (Table 1). Two weeks prior to initiation of fieldwork, the District will provide the contractor with detailed maps showing Global Positioning System (GPS) coordinates for the beginning and end points of each dive transect. In addition, the District Biologist will reserve the option to select up to three additional transects at each site during the field operation. These optional transects will be used to further define areas identified to have low mussel density. The following specifications for diver transects shall apply:

a. Each diver transect will be assigned an alpha-numeric designation based on the study site (numeric) and transect (alpha).
b. Each transect will be 100 m in length running perpendicular to the shoreline.
c. The location of each diver transect will be identified with a Global Positioning System (GPS) coordinates. The District will provide the contractor with detailed maps and GPS coordinates for each site. The contractor will record actual GPS coordinates for each transect.
d. The range and average depth encountered during the diver search shall be recorded.
e. Substrate types encountered along the entire length of the diver transects shall be recorded.
f. A dive log will be maintained to record the following information for each diver transect: diver(s) completing the transect, GPS coordinates, duration (start/end), depth range, average depth, substrate type(s), and number/species of mussels collected.

5.3 Sampling effort: The contractor will perform diver transects at each of the sites shown in Tables 1 as stipulated under item 5.2:

Table 1. Potential sites for mooring cell placement in Pool 15 of the Upper Mississippi River along with the number of pre-selected (PST) and optional (OPT) transects to be completed at each.

	Site	Pool	Rivermile	PST	OPT
1.)	SITE 1	15	492.5L	6	3
2.)	SITE 2	15	491.9L	6	3

5.4 Water quality: will be measured daily at each study site immediately prior to sampling. Measurements will include temperature (surface/bottom), dissolved oxygen (surface/bottom), current velocity (surface/bottom), and transparency (surface). River stage (feet above flat pool) and discharge information (cfs) should also be recorded for each location.

5.5 Descriptive parameters: Individual mussels collected during each diver search will be identified to species and measured (calipers) to the nearest millimeter for shell length. Zebra mussel infestation will be noted by recording an "*I*"- Infested or "*C*" - Clear. For infested mussels, a percent value will be recorded to reflect the portion of the unionids' shell surface area that is covered by zebra mussels (i.e. I-30% or I-90%).

5.6 Data analysis: shall include measures of unionid species abundance and composition at each study site using the following format or methodologies:

(A) Abundance

(1) *Relative species abundance* - total number of individuals of a species expressed as a percentage of the total number of individuals of all species.

(2) *Index of species density* - Catch-per-unit-effort (CPUE) expressed as the number of individuals of each species collected at each sample site (i.e. 10-m intervals).

(B) Composition (compared by diver transect)

(1) *Richness* - Rarefaction method $[E(S_n)]$.

(2) *Evenness* -Abundance plots [species rank (X) -vs- relative abundance (Y)].

(3) *Diversity Indices* - Simpson's (D_s)

(4) *Size frequency distributions* - percentage of population within 5-mm shell length intervals.

5.7 Threatened/Endangered: Should individuals of any federally threatened or endangered species be captured at any time during fieldwork, the contractor shall, as soon as it is convenient, but not to exceed the following day, notify the Districts' Project Biologist. Any federally protected mussels will be sexed, aged, measured, photographed, and hand placed back into the river at their recovery point. Measurements of federally protected mussels will include shell length, width, and height.

VI. SPECIAL CONDITIONS

6.1 The Contractor shall carry a marine band radio and cell phone while conducting fieldwork, to facilitate communication with the Lockmasters and approaching towboats. The marine band radio shall, at a minimum, be equipped with "safety and calling" channel 16 (frequency 156.8 mhz), operating channel 14 (frequency 156.7 mhz) and bridge to bridge" channel 13 (frequency 156.65 mhz). When not being used to receive or transmit a message, the radio shall simultaneously monitor channels 13 and 16.

VII. DIVING SPECIFICATIONS

7.1 Divers will be working in an area subject to fast currents (up to 1 to 3 feet/sec.), deep water (12-40 feet at flat pool), variable bottom conditions, and intermittent commercial barge traffic. Adequate safety precautions should be taken to minimize the risk of bodily injury or damage to equipment. Sufficient time should be allowed in the contractor's proposal to account for standby time when tow traffic is present.

7.2 Diving operations shall adhere to pertinent provisions of the U.S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, dated 3 September 1996 (and all subsequent revisions).

7.3 Diving operations will be monitored and/or inspected by a District employee who is certified as a COE diver, a diving supervisor, or a diving inspector. The contractor shall make provisions to allow a District diver to accompany them during all diving activities. The contractor shall contact CEMVR Diving Point-of-Contact (POC) to schedule field-work.

7.4 The contractor shall develop and maintain a Safe Practices Manual (SPM) which details the contractor's entire diving program. Information requirements of the SPM are detailed in the Safety and Health Requirements Manual. The contractor's SPM must be submitted to the Districts' Diving POC for review (with one copy to the contracting Officer's Representative) at least fifteen days prior to the commencement of dive operations.

VIII. REPORT

8.1 Within 10 days of completion of field sampling the contractor shall provide to CEMVR a preliminary letter report (based on field observations) listing locations within the sample areas in which mussel densities appear to be low. This letter report will not be used to make final site recommendations for a mooring buoy, but will be used to narrow the focus to a potentially viable mooring site.

8.2 The Contractor shall prepare a technical report describing the survey methodology and results of the investigation outlined in Section V above. The report will include copies (hardcopy and electronic) of all field data sheets, and maps and other illustrations will be reproducible in black and white format.

8.3 **Three (3) copies of the draft report** shall be provided to the Contracting Officer's Representative. The Contractor will be responsible for any revisions to the draft report required by the Contracting Officer's Representative. **Fifteen (15) copies of the final report** will be furnished to the Contracting Officer's Representative no later than 30 days from the Contractor's receipt of comments on the draft. One copy of original field collection data/notes (hard copy and electronic), photo logs, photographs, and negatives shall be provided along with the final report.

8.4 The District will provide the contractor with finished copies of maps showing the sampling locations (with GPS coordinates) prior to submission of Draft report (see 9.1).

8.5 This scope-of-work shall be included as an appendix of the final report.

IX. SCHEDULE

9.1 **Project Schedule**: The Contractor may begin work immediately upon award of the work order. The following Project Schedule shall apply:

Tasks	Date
Date of Award	0
Corps to provide site maps	15
Field Work Completed	30
Corps to provide finished copies of maps	45
Draft Report Due	70
Draft Review Period	71-115
Final Report Due	30 days after receipt of comments from CEMVR
Final Report Acceptance by Corps	30 days after receipt of Final Report

9.2 **Fieldwork**: The District anticipates data acquisition to require 1 Malacologist, 2 divers and 1 diver assistant. Actual fieldwork should require approximately 2 working days. Travel Costs for this project will be covered by a previous contract, which already has the contractor near the study area.

9.3 **Payment schedule**: The payment schedule shall be as follows:

PAYMENT SCHEDULE

Tasks	Percent of Contract Amount
1) 100% field work completion	90
2) final report acceptance	10

X. COORDINATION

10.1 Randy Kraciun is the Project Biologist for this work. He may be reached by phone: 309/794-5174, FAX: 309/794-5157, or E-mail: randall.j.kraciun@usace.army.mil.

10.2 Ron Pulcher is the Contracting Officers Representative (COR) for this work. He may be reached by phone: 309/794-5384 or FAX: 309/794-5157.

10.3 James Aidala is the Districts' Point of Contact (POC) for Contract Diving Operations. He may be reached by phone: 309/794-5455 or FAX: 309/794-5180. He shall be contacted to arrange for the Districts' Dive Inspector's presence at all dive operations. Dive and dive safety related questions should be addressed to him (See Section VII, above)

10.4 Lockmaster at Lock and Dam 14 will be notified (309/794-4357) by the contractor at least 24 hours prior to the commencement of fieldwork. The Lockmaster will also be contacted the day(s) of the survey to assure that they know the location of the survey team while on site.

10.5 The Contractor shall make provisions to allow District personnel to accompany them on one or more days of fieldwork.

10.6 It is the Contractor's responsibility to contact the Project Biologist or other District personnel to determine current field conditions regarding water levels and other conditions that might affect initiation or completion of the survey.

XI. LIST OF EXHIBITS

11.1 **Schedule and Provision of Exhibits**: Should the Government fail to provide any of these materials at the time(s) set out herein, the Project Schedule shall be extended 1 calendar day for each calendar day of delay in providing these materials – the extension ending only when the final item is provided or when the contract is modified to remove the item from this Scope of Work. Exceptions. if any, to this provision are stated under the individual exhibit number, below.

Exhibit 1. **Figure 1**. L/D 14 MOORING CELL, Proposed Locations, Site 1 & 2, Pool 15, Mississippi River, –1 sheet, attached.

Exhibit 2. Site Maps to be provided per the Project Schedule.

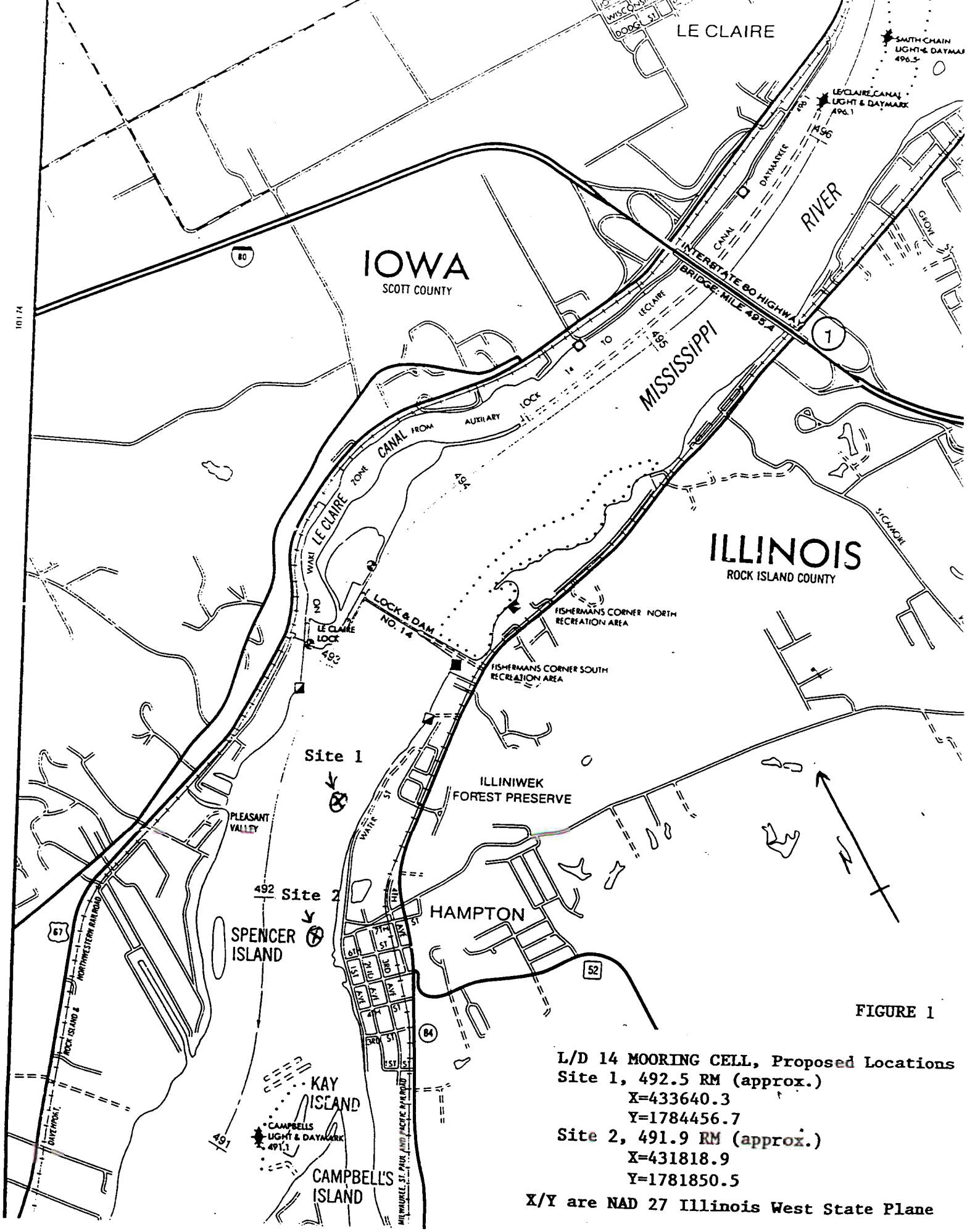

FIGURE 1

L/D 14 MOORING CELL, Proposed Locations
Site 1, 492.5 RM (approx.)
X=433640.3
Y=1784456.7
Site 2, 491.9 RM (approx.)
X=431818.9
Y=1781850.5
X/Y are NAD 27 Illinois West State Plane